(12) UK Patent Application (19) GB (11) 2 259 618 (13) A

(43) Date of A publication 17.03.1993

(21) Application No 9218975.2

(22) Date of filing 08.09.1992

(30) Priority data
(31) 4130040 (32) 10.09.1991 (33) DE

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(51) INT CL[5]
F16D 27/16

(52) UK CL (Edition L)
H2K KFH KSX K210 K252 K440 K451 K452 K453 K598
F2L LE L301 L503
G1N NCTA N19B2F N19D12F N19X5
U1S S2050 S2236

(56) Documents cited
US 4467272 A

(58) Field of search
UK CL (Edition K) G1N NCTA NCTD, G4V VPCB, H2K KFH KJG KSX
INT CL[5] F16D 27/16, G01N 27/72, G01R 27/26 31/00, G07D 5/08, H02H 3/44 3/46 5/00 7/00
Online databases: WPI

(54) Monitoring an electromagnetic clutch

(57) A switched current source 3 drives an electromagnetic clutch 1. The current flowing through the electromagnet is monitored, and is kept between two thresholds by a Schmitt trigger 5 controlling the current source. The thresholds depend on whether the clutch is to be engaged or disengaged. The frequency f_M of the switching (or of the current in the winding) is measured, and compared 10 to a reference frequency f_R to verify that the clutch is positioned correctly.

The circuit is suitable for use in a printing press.

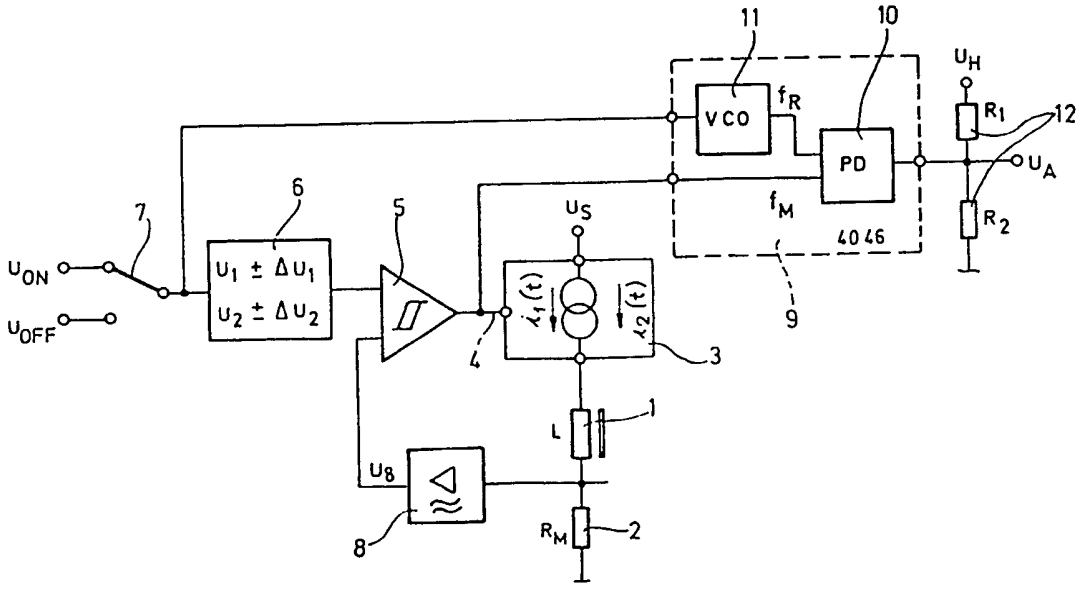

Fig. 1

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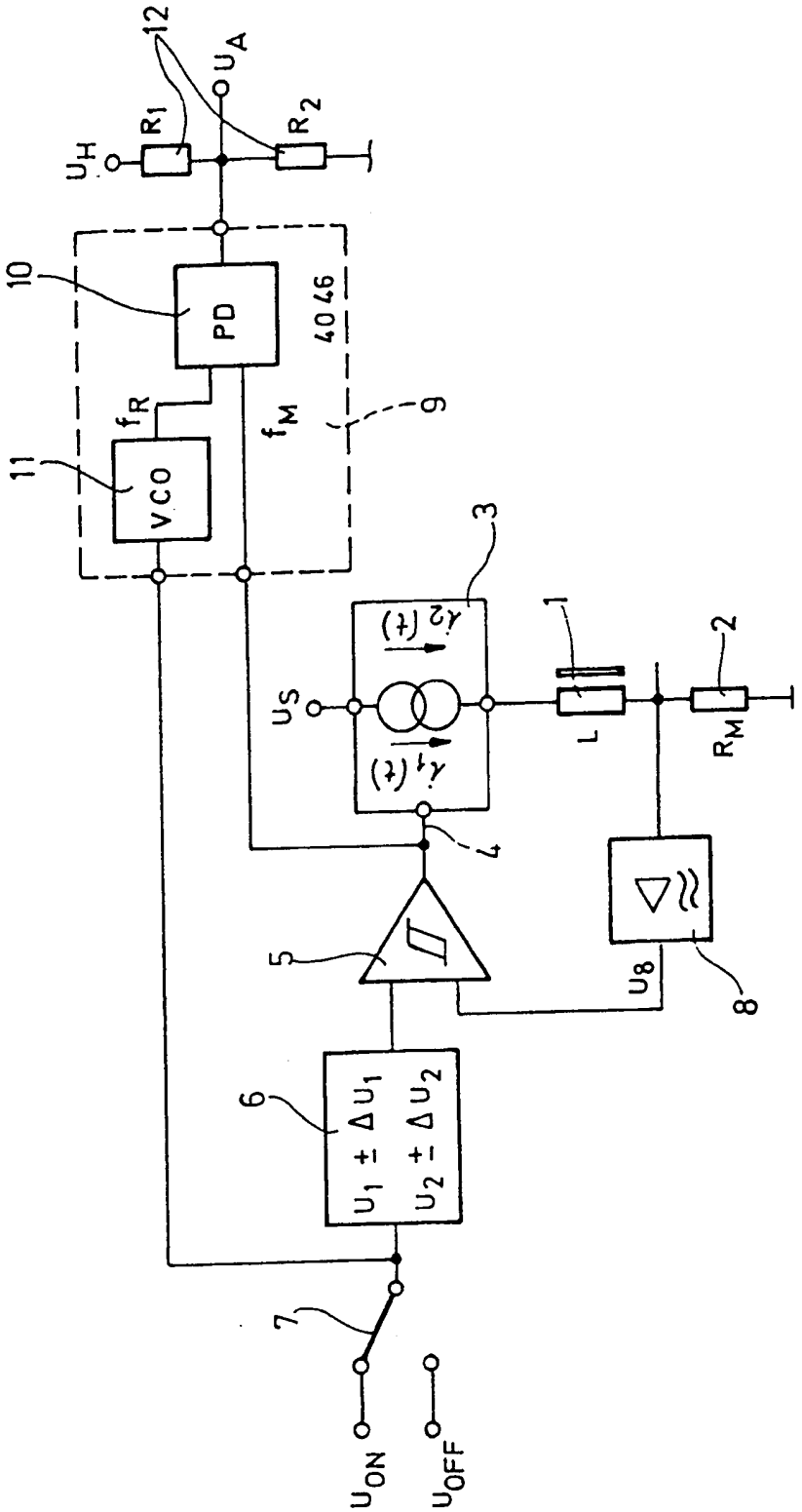
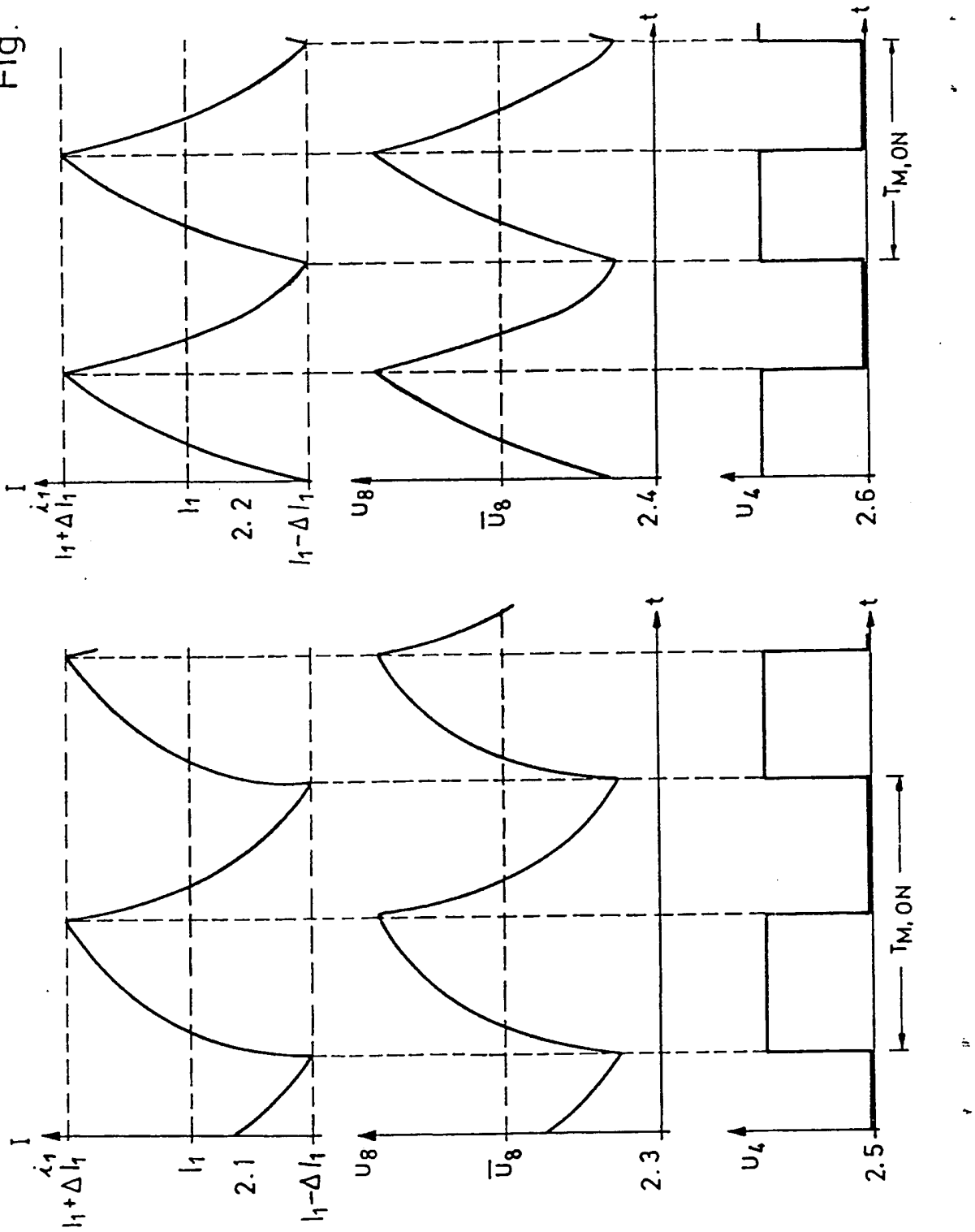

12
U_A
U_H
R_1
R_2
10
PD
4046
f_R
f_M
9
11
VCO
3
$\lambda_2(t)$
$\lambda_1(t)$
U_S
1
L
2
R_M
4
5
U_8
8
6
$U_1 \pm \Delta U_1$
$U_2 \pm \Delta U_2$
7
U_{ON}
U_{OFF}

Fig. 1

Fig. 2



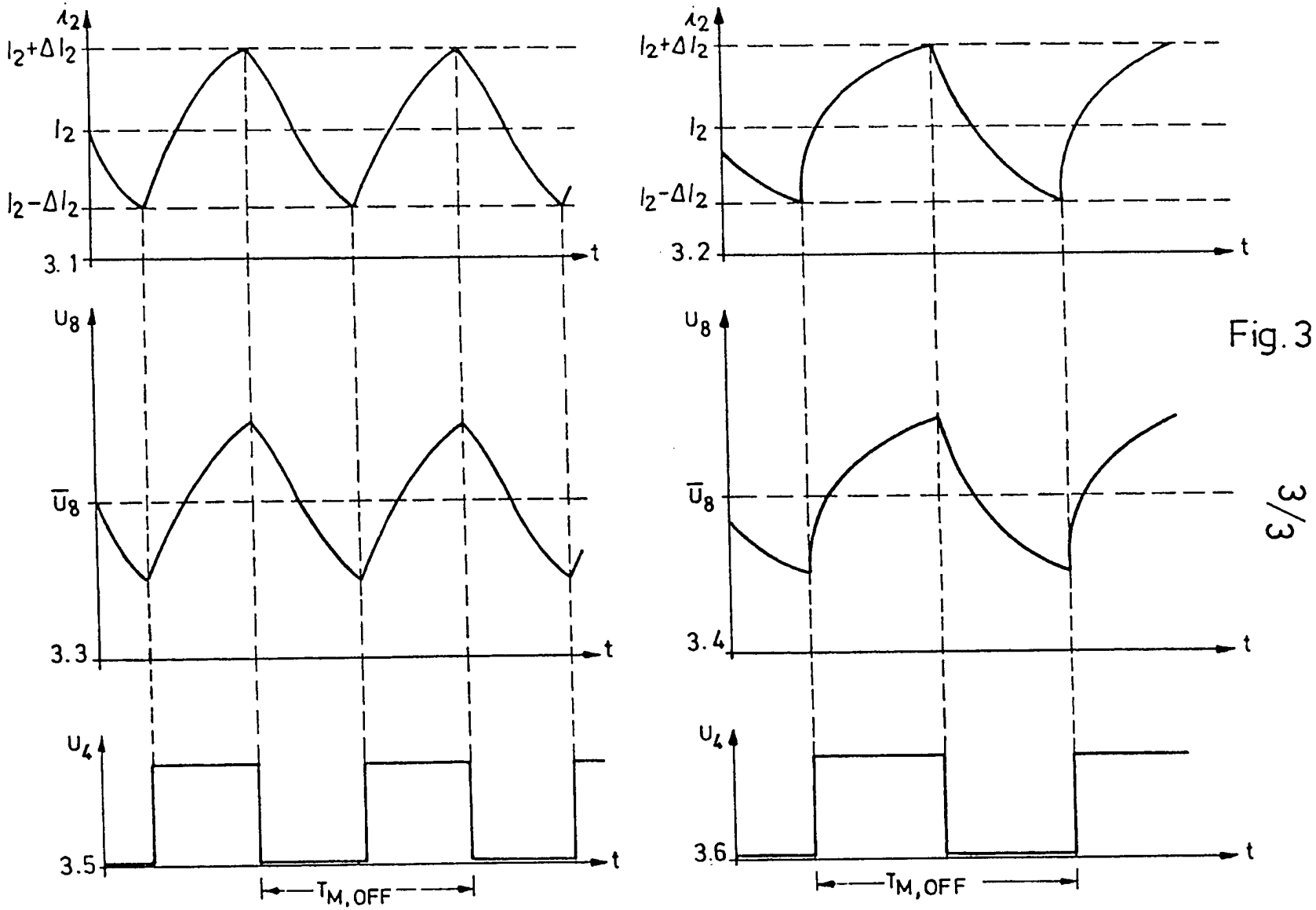

I_2
$I_2+\Delta I_2$
I_2
$I_2-\Delta I_2$
3.1
t
U_8
$\overline{U}_8$
3.3
t
U_4
3.5
t
$T_{M,OFF}$
I_2
$I_2+\Delta I_2$
I_2
$I_2-\Delta I_2$
3.2
t
U_8
$\overline{U}_8$
3.4
t
U_4
3.6
t
$T_{M,OFF}$

Fig. 3

CIRCUIT ARRANGEMENT FOR THE MONITORING OF AN ELECTROMAGNETICALLY OPERATED CLUTCH

The invention relates to a monitoring circuit for an electromagnetic clutch with regard to its engaged and disengaged state.

In machines, particularly in printing presses with complex, electrical and/or electronic controls, it may be necessary to obtain switching signals that provide information on the engaged and disengaged states of an electromagnetically operated clutch. Various possible solutions are known for this purpose.
One solution consists in monitoring the position of that part of the clutch that is moved as a result of engagement/disengagement. In the disengaged state, this part assumes a first position and, after a voltage has been applied to the electromagnet provided for the operation of the clutch, this part assumes a second position. The distance covered by this part from the disengaged to the engaged state is of the order of magnitude of some tenths of a millimetre to a few millimetres and can be measured using conventional position sensors, preferably of the electromechanical, opto-electronic, inductive or capacitive type. In the simplest case, it is possible for a microswitch to be permanently installed on the frame, with said microswitch being actuated precisely when the clutch is in the engaged state.
DE 31 40 259 A1 discloses a circuit arrangement for a power-shift transmission in which hydraulically operated disconnect-type clutches are provided, with a displacement- or pressure-measuring system being

installed in order to determine the position of the clutch. Furthermore, said circuit arrangement is provided with rotational-speed sensors on the input and output sides, said rotational-speed sensors being connected to a control unit including a rotational-speed control loop.

A further solution consists in that an apparatus for displacement or angle measurement is used as an indicator of the engaged state of a clutch, said apparatus being associated with the machine part that is driven by the clutch. The sending of signals from the displacement- and/or angle-measuring apparatuses can be taken as an indication that the clutch is engaged.
A disadvantage of these solutions is that they each require additional, costly apparatuses for the measurement of displacement, angle and/or rotational speed, said apparatuses taking up additional installation space, being complicated to install and, because of their construction and their complexity, adversely affecting reliability with regard to the monitoring of an electromagnetic clutch. Moreover, with such solutions, some of them implemented using mechanical means, it can be expected that, in a rough machine environment, the accuracy with which the position of the moved clutch and machine parts is determined will be lost as a result of mechanical influences and other ambient influences.
With some machines, particularly printing presses, it may be necessary, in addition to the monitoring of the engaged and disengaged state, also to monitor the precise angular position of the connecting parts of a rotating clutch. In the case of toothed clutches, for example, it may happen that, during engagement or as a result of operational disturbances, the teeth are not seated in the mating pieces provided, or that the teeth

do not lock in position precisely and sit in an undefined position on a tooth flank.
The monitoring apparatuses required for this purpose are likewise disposed as additional components on the clutch or on the driving and/or driven machine elements and have the same disadvantages as already described above.

In simple monitoring arrangements for an electromagnetically operated clutch, it is possible, by measuring the DC current consumption of the electromagnet, to obtain a signal for the "clutch engaged" state. Thus, it is possible, for example, in the power lead to the electromagnet, to connect an ohmic resistor in series with the electromagnet, with the voltage drop across said resistor being evaluated. If the voltage drop exceeds a defined threshold value, then it is possible, at the output of a comparator connected to the resistor, to cause a signal edge which can be taken as an indication that the clutch is in the engaged state.
With this solution, it is assumed that, when an electromagnetic clutch is supplied with power, it takes up its intended position; that is, for example, a toothed clutch locks precisely in place with respect to the axial position and angular position of the machine elements that are to be connected. A disadvantage of this is that, as a result of the measurement of the DC current consumption of the electromagnet, it is not possible to detect minor deviations from the precisely engaged state, because, owing to the saturation of the electromagnet in these ranges, there is only an insignificant change in the DC current.

The object of the invention is to develop a circuit arrangement for the monitoring of an electromagnetically

operated clutch, said circuit arrangement permitting, at low cost and with little outlay on materials, the reliable monitoring of the engaged and disengaged states and of the angular position of the connecting machine elements.

The invention consists in that, in the energized and de-energized state of the clutch, the winding of the electromagnet of the clutch is supplied with an AC current, the r.m.s. value of which corresponds, in the energized state, to the nominal current for the engagement of the clutch and the r.m.s. value of which is so low in the de-energized state that, under normal conditions, the clutch safely disengages. A current source, controllable by a window comparator, is provided for supplying the winding. The window comparator has two comparator thresholds each for the energized and de-energized states. In each case, the higher-lying threshold limits the supplied current to a maximum value as of which the current source is disconnected by the output signal from the window comparator.
The supply current then drops to a value that is specified by the respective lower comparator threshold. The current flowing through the winding is measured by an ammeter, preferably a current transformer or a measuring resistor, and is supplied via an amplifier to one of the inputs of the window comparator, with the other input of said window comparator being connected to the reference voltages required for the energized or de-energized state. As a result of the circuit arrangement, the current oscillates through the winding at a frequency which becomes established at a defined value depending on the state at engagement or disengagement. According to the invention, provided for frequency measurement is a frequency meter which may be situated, electrically or floatingly, in the supply line

to the winding or which may, preferably, be connected to the output of the window comparator. The frequency is compared in a comparator with a reference frequency. If the frequency differs from the reference frequency by a specified amount, then it is possible to derive a corresponding signal stating whether the clutch has properly engaged or disengaged. The frequency deviations are caused by the fact that, if the clutch does not properly engage, the air gap in the magnetic circuit of the clutch is too large or too small, with the result that there is a change in the inductance of the winding because of the linearization or non-linearization of the magnetic characteristic curve.

The invention is to be explained in greater detail in the following with reference to the circuit arrangement shown in the drawings, in which:

Fig. 1 shows a block diagram of the circuit arrangement according to the invention; and

Fig. 2 and 3 show timing diagrams for the engaged and disengaged states of the clutch.

In the circuit shown in Fig. 1, connected in series with the winding 1 of an electromagnetically operated clutch are, on the ground side, a measuring resistor 2 and, on the current-supply side, a current source 3, which is connected to a supply voltage U_s. The current source 3 has a control input 4, which is connected to the output of a comparator 5. One input of the comparator 5 is connected to a reference-voltage source 6, which, depending on the position of a switch 7, generates an upper comparator threshold $U_1 + \Delta U_1$ or $U_2 + \Delta U_2$ and a lower comparator threshold $U_1 - \Delta U_1$ or $U_2 - \Delta U_2$. The

other input of the comparator 5 receives, via an AC voltage amplifier 8, the voltage which drops across the measuring resistor 2, said voltage being proportional to the current flowing through the winding 1. Connected to the output of the comparator 4 is a frequency meter 9, which contains a frequency-selective phase detector 10. In addition to the measured frequency f_M, the phase detector 10 is supplied with a reference frequency f_R for the purpose of comparison. The reference frequency f_R is generated by a voltage-controlled oscillator 11, whose control-voltage input is connected to the switch 7. The frequency meter 9 of type 4046 has a tristate output, with the result that, through the intermediary of the voltage divider 12 with $R_1 = R_2$, it is possible to obtain a signal for the magnitude and direction of the deviation of the measured frequency f_M from the reference frequency f_R.
The frequency meter 9 may likewise be connected via an additional preamplifier into the connecting line between winding 1 and measuring resistor 2 or to the output of the amplifier 8. In any case, the frequency meter 9 measures the frequency f_M of the AC current component in the winding 1.

Fig. 2 shows the timing diagrams for the state in which the switch 7 is set to U_{ON}, i.e. the state in which the clutch is to engage. For this energized state, the threshold voltages $U_1 + \Delta U_1$ and $U_1 - \Delta U_1$ are set to one of the inputs of the comparator 5. The current which flows in this case through the winding 1 is shown, for the non-properly engaged state, in Fig. 2.1 and, for the properly engaged state, in Fig. 2.2. The corresponding timing diagrams at the output of the amplifier 8 and at the output of the comparator 5 are shown, for the non-properly engaged state, in Fig. 2.3

and 2.5 and, for the properly engaged state, in Fig. 2.4 and 2.6.

With respect to the state shown in Fig. 3.1 - 3.6, analogously as in Fig. 1, where the switch 7 is connected to U_{OFF}, the differences with respect to the energized state consist in that the clutch is to be disengaged; the differences with respect to the energized state lie in the fact that the comparator thresholds $U_2 + \Delta U_2$ and $U_2 - \Delta U_2$ are so low that the r.m.s. value of the current through the winding 1, as shown in Fig. 3.1 and 3.2, does not cause the clutch to engage or that, under normal conditions, the clutch safely disengages.

Depending on whether the clutch is engaged or disengaged, the current through the winding has an AC component of different frequency. The frequency t_M and the period T_M are measured with the frequency meter 9 and are compared with a reference frequency f_R. Depending on whether the measured frequency f_M is greater or smaller than the reference frequency f_R, it is possible to deduce from the magnitude of the frequency deviation whether the clutch has properly engaged or disengaged.
The reference frequency f_R may advantageously be chosen such that it lies in the middle between the two frequency deviations. Via the control input of the oscillator 11 it is possible to select different reference frequencies f_R for the energized and de-energized states.

It will of course be understood that the present invention has been described above purely by way of example, and modifications of detail can be made within the scope of the invention.

CLAIMS:

1. Circuit arrangement for the monitoring of an electromagnetically operated clutch, in which the winding of the electromagnet is connected to a switchable current source, in which an ammeter is in series with the winding of the electromagnet, the winding being connected to the current source in the energized and de-energized states, and the current source being connected to a window comparator via a first control input; in that an AC voltage amplifier is provided and is assigned to an ammeter with its output connected to the first input of the window comparator; in that a second input of the comparator is connected to a reference-voltage source, which has two comparator thresholds depending on the energization and de-energization signal; and in which a frequency meter is provided for measuring the frequency of the AC current component in the winding, said frequency meter being connected to a further comparator, with a reference-frequency generator being connected to the second input of said comparator.

2. Circuit arrangement for the monitoring of an electromagnetically operated clutch substantially as hereinbefore described with reference to the accompanying drawings.

Patents Act 1977
Examiner's report to the Comptroller under Section 17 (The Search Report)

Application number
GB 9218975.2

Relevant Technical fields

(i) UK Cl (Edition K) H2K (KFH,KJG,KSX) G4V (VPCB)
G1N (NCTA,NCTD)

(ii) Int Cl (Edition 5) H02H (3/44,3/46,5/00,7/00)
G01R (31/00,27/26)
F16D (27/16) G01N (27/72)
G07D (5/08)

Databases (see over)

(i) UK Patent Office

(ii) ONLINE DATABASES: WPI

Search Examiner
PAUL NICHOLLS

Date of Search
1 DECEMBER 1992

Documents considered relevant following a search in respect of claims 1-2

Category (see over)	Identity of document and relevant passages	Relevant to claim(s)
X	US 4467272 A (HASSLER AND FRIZ) Figures 3 and 4	1

Category	Identity of document and relevant passages	Relevant to claim(s)

Categories of documents

X: Document indicating lack of novelty or of inventive step.

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